TITLE OF THE INVENTION

DRUM WASHING MACHINE AND METHOD OF CONTROLLING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 2003-53153, filed July 31, 2003 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates, in general, to drum washing machines, and, more particularly, to a drum washing machine, and a method of controlling the drum washing machine, which determines an amount of load of laundry according to a number of water supplement operations due to variations of a water level.

2. Description of the Related Art

[0003] Generally, a drum washing machine is a device that washes laundry using drops generated by rotation of a rotary tub having a drum shape.

[0004] In a conventional drum washing machine, a set amount of water is fed into a water tub, and then a rotary tub is rotated in opposite directions so as to allow laundry to be uniformly soaked with the water. Therefore, the laundry absorbs water and a current water level is low compared to an initial water level due to absorption of water by the laundry. Therefore, supplementary water is fed to restore the current low water level to the initial water level.

[0005] In the conventional drum washing machine, the amount of load of laundry is determined according to the number of water supplement operations. That is, if the number of water supplement operations is large, it is determined that the amount of load of laundry is large, while if the number of water supplement operations is small, it is determined that the amount of load of laundry is small in proportion to the number of water supplement operations.

The amount of load of laundry is used as basic data for later washing, rinsing and drying processes.

[0006] Generally, times required for laundry to sufficiently absorb water differ according to materials making up the laundry. Further, even in the case of laundry made of similar materials, degrees to which the laundry absorbs water and times in which the laundry absorbs water differ according to states in which the laundry is arranged. For example, if clothes of the laundry are overlapped or massed, differences in the degrees and times will be large.

[0007] However, in the conventional drum washing machine, only the rotary tub is rotated in opposite directions to allow water to be absorbed in the laundry. Therefore, in the case where laundry having a relatively low water absorptivity is arranged in the rotary tub, or clothes of the laundry are overlapped or massed, the laundry is not sufficiently and uniformly soaked with the water within a short time. Consequently, there is a problem in that it is difficult to precisely determine the amount of load of the laundry within a short time.

SUMMARY OF THE INVENTION

[0008] Accordingly, it is an aspect of the present invention to provide a drum washing machine, and a method of controlling the drum washing machine, which precisely determines an amount of a laundry load within a short time by allowing the laundry to be sufficiently and uniformly soaked with water within a short time.

[0009] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0010] The above and/or other aspects are achieved by providing a drum washing machine comprising a water tub, a rotary tub rotatably provided in the water tub, a pumping unit to pump water contained in a lower portion of the water tub into the rotary tub, and a control unit to control the pumping unit, wherein the control unit controls the pumping unit to pump the water contained in the lower portion of the water tub into the rotary tub while determining an amount of a laundry load.

[0011] The pumping unit may include a circulating pipe having a first end coupled to an inside of the water tub and a second end disposed at an inlet of the rotary tub, a pump to pump the water contained in the water tub into the rotary tub, and a spray nozzle disposed at the second end of the circulating pipe.

[0012] The drum washing machine may include a motor to rotate the rotary tub, wherein the control unit controls the motor to rotate the rotary tub in opposite directions while controlling an operation of the pumping unit.

[0013] The drum washing machine may include a water level sensor to detect a water level of the rotary tub, wherein the control unit determines the water level from the water level sensor in response to the pump and the motor being simultaneously stopped.

[0014] The dram washing machine may include a key input unit to receive washing courses according to materials of the laundry load, wherein the control unit operates the pump according to ON-OFF periods corresponding to the washing courses.

[0015] The key input unit may be provided with washing course buttons for one or more of cotton fabrics, mixed fabrics, woolen fabrics and synthetic fibers. The ON-OFF periods of the pump may be set according to a chosen one of the washing course buttons. Durations of OFF periods of the ON-OFF periods may increase from the cotton fabrics, to the mixed fabrics, to the woolen fabrics, to the synthetic fibers.

[0016] The above and/or other aspects may also be achieved by providing a method of controlling a drum washing machine, the drum washing machine having a water tub, a rotary tub, and a pumping unit to pump water contained in a lower portion of the water tub into the rotary tub, the method including feeding a set amount of water according to a selected washing course, and operating the pumping unit to pump the water contained in the lower portion of the water tub into the rotary tub while determining an amount of a laundry load.

[0017] The drum washing machine control method may include operating a motor to rotate the rotary tub in opposite directions while controlling an operation of the pumping unit.

[0018] The drum washing machine control method may include determining a water level of the rotary tub through a water level sensor, which detects the water level of the rotary tub, in response to the pumping unit and the motor being simultaneously stopped.

[0019] The pumping unit may be designed so that a time duration of pumping operations thereof is preset according to materials of the laundry load.

[0020] The time duration of pumping operations of the pumping unit may increase from a cotton fabrics washing course, to a mixed fabrics washing course, to a woolen fabrics washing course, to a synthetic fiber washing course.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a perspective view showing an internal structure of a drum washing machine, according to an embodiment of the present invention;

FIG. 2 is a control flowchart of a method of controlling the drum washing machine, according to an embodiment of the present invention;

FIGS. 3A and 3B are timing diagrams showing a procedure of reading a water level value from a water level sensor so as to detect a current water level of a rotary tub in FIG. 2;

FIG. 4 is a control flowchart showing a method of setting an ON-OFF period of a pump according to washing course buttons which are chosen by a user based on materials of laundry; and

FIGS. 5A, 5B, and 5C are timing diagrams showing the ON-OFF period of the pump according to buttons of FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

[0023] FIG. 1 is a perspective view showing an internal structure of a drum washing machine, according to an embodiment of the present invention. As shown in FIG. 1, the drum washing machine of the present invention includes a water tub 10 and a rotary tub 11 rotatably provided in the water tub 10.

[0024] A water feed pipe 12 is mounted at the water tub 10 to guide a flow of water flowing from an external water supply pipe into the water tub 10. A water feed valve 13 is mounted at the water feed pipe 12 to control the flow of water. A detergent container 14 is mounted at the water feed pipe 12.

[0025] A drain pipe 15 is disposed between a bottom of the water tub 10, containing water flowing through the water feed pipe 12 in a lower portion thereof, and a drain-outlet. A drain pump 16 and a drain valve 17 are mounted at the drain pipe 15 to pump the water contained in the lower portion of the water tub 10.

[0026] A circulating pipe 18, branched from the drain pipe 15, is disposed at a portion of the drain pipe 15 between the drain pump 16 and the drain valve 17. The circulating pipe 18 is constructed so that one end thereof is connected to an inside of the water tub 10, and a remaining end thereof is provided at an inlet of the rotary tub 11 so as to circulate the water contained in the water tub 10 to the rotary tub 11. Further, a spray nozzle 18a is disposed at the remaining end of the circulating pipe 18 to spray the circulated water into the rotary tub 11. Further, a circulating valve 19 is mounted at the circulating pipe 18 to prevent water from flowing into the circulating pipe 18 when draining. The circulating pipe 18, the drain pump 16, the spray nozzle 18a, and the circulating valve 19 form a pumping unit.

[0027] Moreover, a reversible motor 20 is coupled to the rotary tub 11, which is rotated by an operation of the motor 20. Further, although not shown in FIG. 1, a water level sensor is mounted in the rotary tub 11 to detect a water level of the rotary tub 11.

[0028] The water feed valve 13, the motor 20, the drain pump 16, the drain valve 17, the circulating valve 19, and the water level sensor are electrically connected to a control unit that performs an entire control operation of the drum washing machine.

[0029] Further, an input side of the control unit is connected to washing course buttons (not shown) to receive information on materials of laundry, such as cotton fabrics, woolen fabrics, and synthetic fibers, from a user. As will be described later, the control unit controls the number of pumping operations of the drain pump 16 to be varied by setting an ON-OFF period of the drain pump 16 in response to signals received from the buttons.

[0030] Hereinafter, a method of controlling the drum washing machine of the present invention is described through a detailed operating process of the drum washing machine.

[0031] FIG. 2 is a control flowchart of a method of controlling the drum washing machine, according to an embodiment of the present invention. Referring to FIG. 2, the water feed valve 13 is turned on for a certain period, so that water is fed into the water tub 10 until a level of the water reaches a preset water level in operation 100. Accordingly, water flowing from the water feed pipe 12 fills a lower portion of the water tub 10 through the detergent container 14.

[0032] After the water is fed up to the preset water level, the control unit controls the reversible motor 20 to rotate in forward and reverse directions so as to rotate the rotary tub 11 in opposite directions, and thus allow laundry to be sufficiently and uniformly soaked with water, in response to a signal indicating that a water level detected by the water level sensor reaches the preset water level in operation 110. Simultaneously, the control unit controls the drain pump 16 to allow water contained in the lower portion of the water tub 10 to be circulated into the rotary tub 11, and then sprayed onto the laundry, in operation 110.

[0033] Accordingly, although clothes of the laundry contained in the rotary tub 11 may be overlapped or massed, overlapped or massed states of the laundry are removed by the opposite directional rotation of the rotary tub 11 and the water circulation and spray operation. Therefore, the laundry is sufficiently and uniformly soaked with water within a short time.

[0034] Thereafter, to determine whether feeding of supplementary water is required, a water level is read from the water level sensor to detect a current water level of the rotary tub 11 in operation 120. At this time, the water level is read during an interval when both the motor and the pump are simultaneously turned off so as to detect a precise water level.

[0035] It is determined whether the feeding of supplementary water is required, depending on the read water level, in operation 130. That is, if the read water level of the rotary tub 11 is lower than the preset water level, it is determined that the feeding of supplementary water is required. On the contrary, if the read water level of the rotary tub 11 is not lower than the preset water level, it is determined that the feeding of supplementary water is not required.

[0036] If the current water level of the rotary tub 11 is lower than the preset water level, and it is therefore determined that the feeding of supplementary water is required in operation 130, the

water feed valve 13 is turned on to feed supplementary water so as to increase the current water level to the preset water level in operation 140.

[0037] Thereafter, the control unit repeatedly performs a series of operations in which laundry is allowed to be soaked with water and the supplementary water is fed, depending on the variations of the water level, for a preset period.

[0038] Further, the control unit determines whether the preset period has elapsed in operation 150. If the preset period has not elapsed in operation 150, the control unit performs operation 110 and repeats the operations of allowing the laundry to be soaked with water and feeding the supplementary water depending on the variations of the water level.

[0039] Morevoer, if the preset period has elapsed in operation 150, the number of water supplement operations performed during the preset period is determined in operation 160.

[0040] Further, the amount of load of the laundry is determined depending on the determined number of water supplement operations in operation 170. That is, if the number of water supplement operations is large, it is determined that the amount of load of the laundry is large, while if the number of water supplement operations is small, it is determined that the amount of load of the laundry is small.

[0041] FIGS. 3A and 3B are timing diagrams showing a procedure of reading a water level from the water level sensor so as to detect a current water level of the rotary tub, as in operation 120 in FIG. 2. As shown in FIGS. 3A and 3B, the motor 20 and the drain pump 16 have different ON-OFF periods. However, the ON-OFF periods of the motor 20 and the drain pump 16 are set to have intervals T_1 during which the motor 20 and the drain pump 16 are simultaneously turned off.

[0042] The control unit reads a water level from the water level sensor during the intervals T_1 when the motor 20 and the drain pump 16 are simultaneously turned off, so as to detect a precise water level.

[0043] FIG. 4 is a control flowchart showing a method of setting the ON-OFF period of the pump according to washing course buttons, which are chosen by a user based on the materials of the laundry. FIGS. 5A, 5B, and 5C are timing diagrams showing the ON-OFF period of the pump according to the washing course buttons of FIG. 4.

[0044] Referring to FIGS. 5A-5C, with FIG. 4 taken into consideration, the ON-OFF period of the pump is set according to the washing courses classified by the materials of the laundry, such as cotton fabrics, mixed fabrics, woolen fabrics and synthetic fibers.

[0045] For example, in the case of cotton fabrics having a relatively large amount of load and high absorptivity, the ON-OFF period of the pump is set to be shorter than those for other fabrics, so that the number of pumping operations of the pump is increased, thereby enabling laundry to be sufficiently soaked with water within a short time.

[0046] Further, in the case of mixed fabrics having a similar amount of load, but low absorptivity compared to the cotton fabrics, the ON-OFF period of the pump is set to be next to that for the cotton fabrics in ON-OFF periods set in order from shortest to longest, thus reducing the number of pumping operations of the pump compared to the cotton fabrics.

[0047] Meanwhile, the woolen fabrics have a small amount of load compared to the cotton fabrics and the mixed fabrics, but have very high absorptivity according to material and texture properties of the woolen fabrics. Further, the synthetic fibers have a small amount of load, small volume, small thickness, and low absorptivity compared to the cotton fabrics and mixed fabrics, so that the amount of water required for washing is small. Therefore, in the case of the woolen fabrics and the synthetic fibers, the ON-OFF period of the pump is set to be relatively longer than those for the cotton fabrics and the mixed fabrics, thus reducing the number of pumping operations of the pump compared to the cotton fabrics and mixed fabrics.

[0048] As is apparent from the above description, the present invention provides a drum washing machine, and a method of controlling the drum washing machine, which circulates water contained in a water tub into a rotary tub to be sprayed onto laundry simultaneously with the rotation of the rotary tub in opposite directions, so that the laundry is sufficiently and uniformly soaked with water within a short time, and then the amount of load of the laundry is precisely determined, thus rapidly determining the amount of load of the laundry and improving reliability of the determination.

[0049] Further, the present invention is advantageous in that it controls the number of water circulation and spray operations performed by a pump according to the materials of the laundry, thus precisely determining the amount of load of laundry within a short time.

[0050] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.